Quantifying Floodplain Impacts in an Unsteady Flow and 2D Modeling Environment, Implications for 44 CFR 60.3

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Outline

- Historical Perspective
  - Flood Insurance Act 1968
- 44 CFR 60.3
  - Floodways
  - Cumulative Rise Criteria (A or AE without floodway)
- 1D Flood Models
  - Steady State
  - Floodway Methodology
- 2D Flood Models
  - Unsteady State
- FEMA Regulatory Implications
  - 44 CFR 60.3 Revisited
- Case Study
Historical Perspective

- **National Flood Insurance Act 1968**
  - Regulations reflect technical capabilities at the time
  - Based on technology framework from 1970’s

- **FEMA Guidance**
  - Written when steady state 1D models were state of the art

- **FIRMs and FISs**
  - Mapping entire country on limited budget
  - Limited topographic data
  - Manual model edits were more labor intensive

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HEC-2
Water Surface Profiles

User's Manual

September 1990
Revised September 1991
State of the Art?
44 CFR 60.3

- AE with a floodway
- AE without a floodway

(10) Require until a regulatory floodway is designated, that no new construction, substantial improvements, or other development (including fill) shall be permitted within Zones AI-30 and AE on the community's FIRM, unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community.
1D Steady State Modeling

- Step Backwater Computations
  - Downstream to upstream (subcritical)

- Steady State
  - Point A experiences same flow as Point B
  - No flow attenuation
  - Can be conservative when hysteresis is present

- One Dimensional Flow
  - Single Water Surface
  - Averaged Hydraulics
  - Impacts are the same across floodplain
FEMA Floodway

- Encroachment on the 100-yr floodplain so that water surface rises 1.0 ft maximum (federal standard)
Practitioner’s Challenges

- FEMA Modeling Guidance
  - Process Developed for 1D models
  - Assumes non-bifurcated flows
  - Equal Conveyance Encroachment
  - Single Stream Channel
- Flood Insurance Rate Maps
  - BFE Lines and floodway section lines
  - Floodway Boundaries
  - Zone Designation
- Flood Insurance Studies
  - Floodway Data Table
  - Profiles
2D Modeling

- **Advantages**
  - Dispersive shallow flow
  - No guessing at cross section orientations
  - More informative static and dynamic mapping
  - Able to simulate flow bifurcations
  - Timing and volume changes quantified
  - Unsteady simulation will capture flow attenuation and hysteresis
  - More robust mapping

Source: Bill Syme - TUFLOW
2D Modeling in 2018

- Federal Agencies Investing in 2D Models
  - FHWA - SRH2D
  - US Army Corps – HEC-RAS

- Computer Hardware
  - Processing speeds
  - Computations spread over multiple cores
  - 64-bit processing
  - Increases in RAM

- Cheaper Storage
  - Terabytes of data
Comparison of 2D versus 1D Sections
2D Cross-Section

![2D Cross-Section Graph](image)

1D Cross-Section

![1D Cross-Section Graph](image)
How much do these differences matter?

- **Design**
  - Where is flow?
  - How much water?
  - Frequency of inundation
  - Improved discretization of velocity and depth
  - Project Impacts

- **Regulatory**
  - Is the public aware?
  - What are the risks?
6.0 Floodway Determination

A floodway is a tool to assist communities in balancing development within the floodplain against the resulting increase in flood hazard. The Mapping Partner must coordinate with the community when developing floodways.

A regulatory floodway is defined as the channel of a river or other watercourse and the adjacent land area that is reserved from encroachment in order to discharge the base flood without cumulatively increasing the water-surface elevation by more than a designated height. NFIP regulations designate a maximum height of 1.0 foot. The portions of the floodplain beyond the floodway are called the floodway fringe. The community is responsible for maintaining the floodway to mitigate flood hazards; the community must not allow any activities causing a rise in the BFE in the regulatory floodway. For more information about conducting a one-dimensional floodway analysis see the Floodway Analysis and Mapping Guidance.
44 CFR Revisited

“Cumulative Impacts”
- Project specific impacts
- Localized impacts are greater than 1D models predicted
- Not spread out across a floodplain
- Downstream flow Increases
- Redirection of flow
- Timing impacts
Rethinking Map Products

- Steady- vs. Unsteady-state?
  - Timing, upstream and downstream peak flow and stage impacts
- Zones AO with depth designation?
  - Used due to limited capability?
- 2D model shallow sheet flow capability.
  - Zone AE with defined elevations to replace AO?
- BFE lines vs. Gridded Water Surface?
- Profile Lines vs. “Point and Click” location specific elevations?
Floodway “Problem”

- Does Floodway even make sense when 2D is needed?
- Flow dynamics don’t follow a 1D paradigm.
  - Localized impacts
  - Flow redistribution
- How about Depth x Velocity criteria?
- Zone AE no floodway Project Specific Impacts?
  - Cumulative Rise Tracking using modern tools
Case Study

- Douglas County, NV
- 50 stream miles
- 20,000 acres of Zone AE
- 11 Panels Revised
- PMR
- Highly Braded Shallow Flow
- Mixed Zone Designations
- Outdated Mapping
  - Hydrology & Hydraulics 1980’s
Existing Mapping

- Flood Hazard Areas
  - A
  - AE
  - AH
  - AO
  - Floodway
True Cumulative Rise

- Requires Impact Analysis for Development Permit
- Regional 1D/2D HEC-RAS Model Distributed to Developers
- Douglas County Manages and Updates
- Zone AE no Floodway
- Tracking Cumulative Rise
- “ZONES” of impact
- Track changes
- Floodway “pockets”
Where are we going?

- Improved and Updated Regulations
- Publically Available Software
- Industry wide understanding of modeling capabilities and impacts
- Training practitioners and reviewers
- Navigating impacts to flood insurance products
- Things are headed in the right direction!!